Construction and Application of Personalized Recommendation Model for Smart Tourism Based on AI Technology

Zhaojian Liu[1,*], Yinjuan Hu[2]

[1]Faculty of Hospitality and Tourism Management, Macau University of Science and Technology, Macao, China

[2]School of Economics and Management, Qinghai Minzu University, Xining, China

*Corresponding author: liuzhaojian2024@163.com

Keywords: Smart Tourism; Personalized Recommendation; Artificial Intelligence; Machine Learning; Deep Learning

Abstract: As artificial intelligence technology continues to advance, the smart tourism industry, which integrates tourism with information technology, is increasingly in need of personalized recommendation services. This study focuses on the development and application of smart tourism personalized recommendation models based on AI technology, aiming to provide tourists with more accurate and personalized tourism recommendations by integrating AI core technologies, such as machine learning and deep learning. It meets the diverse needs of tourists, improves the quality and efficiency of tourism services, and promotes the innovative development of the tourism industry. This study focuses on the development and application of smart tourism personalized recommendation models, aiming to address the contradiction between the diversification of tourist needs and the limitations of traditional recommendation methods by integrating core technologies such as machine learning and deep learning. Additionally, this study thoroughly examines the theoretical foundations, model construction, case analysis, challenges, countermeasures, and prospects, offering significant academic and practical insights into smart tourism personalized recommendations.

1. Introduction

In today's digital age, artificial intelligence technology is rapidly penetrating various industries, bringing new opportunities and challenges to the industry's development. As a vital part of the global economy, the tourism industry is also actively seeking deep integration with information technology, and smart tourism has emerged. Smart tourism leverages advanced technologies, including the Internet of Things, big data, and artificial intelligence, to enable intelligent management of tourism resources and the personalized provision of tourism services. However, with the increasing diversification and personalization of tourists' needs, traditional travel recommendation methods can no longer meet tourists' needs, and there is an urgent need to utilize AI technology to build a more accurate and efficient personalized recommendation model.

This study develops a smart tourism personalized recommendation model based on AI technology, which holds significant theoretical and practical implications. On the theoretical level, this study contributes to enriching the theoretical system in the field of smart tourism and personalized recommendation, providing new ideas and methods for subsequent research. On the practical level, the application of this model can meet the personalized needs of tourists and enhance their travel experience. At the same time, it can also enhance the service quality and operational efficiency of tourism enterprises, promoting the innovative development of the tourism industry.

By combing through the current status of related research at home and abroad, it is found that there are still some deficiencies in current research, including data processing, algorithm optimization, and model evaluation. For example, in data processing, how to effectively integrate multi-source heterogeneous data and improve data quality is still an urgent problem to be solved; in algorithm optimization, the existing recommendation algorithms often have problems such as low recommendation accuracy and poor real-time performance when processing large-scale data and

  DOI: 10.25236/gemmsd.2025.052

complex scenarios; in model evaluation, there is a lack of unified evaluation standards and methods, making it difficult to objectively compare the performance of different models.

In response to the above problems, this study will employ a combination of literature research, case analysis, and experimental research to innovate in model construction and application. Specifically, this study will focus on the following innovations: First, this research integrates multiple AI technologies to build a more efficient and accurate personalized recommendation model. Second, it proposes a new data processing and user portrait construction method to improve data quality and the accuracy of user portraits. Third, it designs a new algorithm fusion and optimization strategy to improve the performance and real-time performance of the recommendation algorithm. Fourth, it establishes a set of scientific and reasonable model evaluation indicators and methods, providing a basis for model optimization and improvement.

In practice, the personalized recommendation model developed in this study can provide tourists with more accurate and personalized travel recommendations, cater to the diverse needs of tourists, and enhance their travel experience. For tourism companies, this model can help them better understand the needs and preferences of tourists, optimize the design and operation of tourism products and services, improve service quality and efficiency, and reduce operating costs, thereby enhancing the competitiveness of enterprises. In addition, the application of this model can also promote the innovative development of the tourism industry, promote the deep integration of the tourism industry and information technology, and provide new impetus for the transformation and upgrading of the tourism industry.

2. Technical Theories

2.1 Core Theory of AI Technology

2.1.1 Machine Learning Algorithms

Machine learning is a core area of artificial intelligence. Its core idea is to let computers learn rules and patterns from data, thereby achieving prediction and decision-making for unknown data. In smart tourism personalized recommendations, machine learning algorithms play a vital role. Commonly used machine learning algorithms include collaborative filtering algorithms and content filtering algorithms [1].

The collaborative filtering algorithm is based on the user's behavior data. It recommends travel projects that the target user may be interested in by finding user groups with similar interests and behaviors to the target user. The algorithm can be divided into user-based collaborative filtering and project-based collaborative filtering. User-based collaborative filtering first calculates the similarity between the target user and other users, then selects user groups with higher similarity and recommends projects they like to the target user. Project-based collaborative filtering, on the other hand, first calculates the similarity between projects and then recommends projects similar to those the target user likes to the target user.

The content filtering algorithm is based on the content features of the project. It recommends projects that match the target user's interests based on their interest preferences and the content features of the project. The algorithm must first extract and represent the project's content, then build a user's interest model based on their historical behavior data, and finally make recommendations based on the user's interest model and the project's content features.

2.1.2 Deep Learning Model

Deep learning is a branch of machine learning that constructs multi-layer neural networks to learn the deep features and patterns inherent in data. Deep learning models offer unique advantages in processing complex data and feature learning and have been widely applied in smart tourism for personalized recommendations.

Common deep learning models include convolutional neural networks (CNNs), recurrent neural networks (RNNs), and deep belief networks (DBNs), among others. Convolutional neural networks are mainly used to process two-dimensional data such as images and videos. They extract local and

global features of data through convolutional layers and pooling layers; recurrent neural networks are primarily used to process sequential data, such as text and speech [2]. They utilize memory units to store historical information, enabling the modeling of sequence data. Deep belief networks are a probabilistic generation model that employs multi-layer neural networks to learn the probability distribution of data, thereby facilitating data generation and prediction. Figure 1 explains the key differences between artificial intelligence, machine learning, and deep learning.

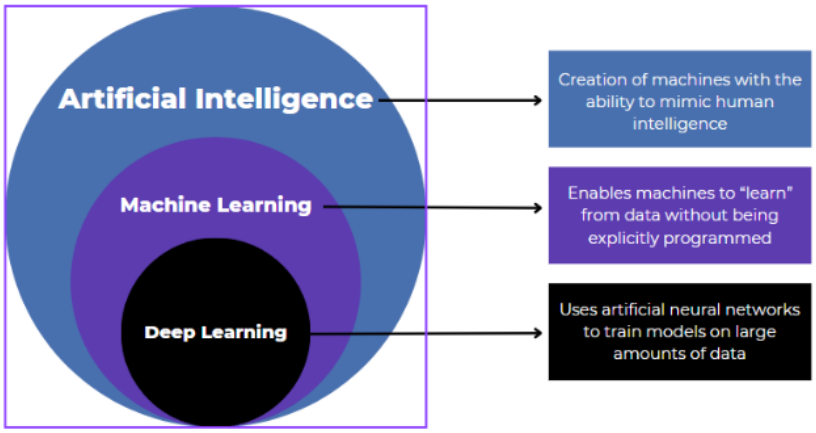

Fig. 1 Key differences between AI, machine learning, and deep learning

2.1.3 Natural Language Processing Technology

Natural language processing is a crucial field of artificial intelligence that enables computers to understand, process, and generate natural language. In smart tourism, personalized recommendations utilize natural language processing technology to understand user needs and generate tailored content recommendations.

Natural language processing technology encompasses lexical analysis, syntactic analysis, semantic analysis, text generation, and other related aspects. Lexical analysis is mainly used to segment and tag natural language texts; syntactic analysis is mainly used to analyze the syntactic structure of natural language texts; semantic analysis is mainly used to understand the semantic meaning of natural language texts; text generation is mainly used to generate natural language recommendation content based on user needs and the results of recommendation models.

2.2 Current Status of Smart Tourism Development

Currently, smart tourism is receiving extensive attention and development worldwide. Many countries and regions have launched smart tourism projects and plans. In terms of technical applications, the Internet of Things, big data, artificial intelligence, and other technologies are increasingly widely used in smart tourism. Services such as smart tour guides, virtual tourism, and personalized recommendations have been initially applied [3]. However, although smart tourism has achieved certain development, it still faces some challenges in practical applications. For example, the data quality is uneven, and the integration of multi-source heterogeneous data is difficult; the performance and real-time performance of the recommendation algorithm need to be improved, and it is difficult to meet the personalized needs of tourists; the dynamic changes of tourism resources and the difficulty of real-time recommendation are relatively large.

In the future, the development of smart tourism is expected to exhibit the following trends: First, the integration of technologies will become more in-depth. Technologies such as the Internet of Things, big data, artificial intelligence, and 5G will be further integrated to provide stronger technical support for the development of smart tourism. Second, services will become more personalized and intelligent. Through in-depth analysis and mining of tourist behavior data, more accurate and personalized travel recommendations and services will be provided to tourists. Third, the tourism industry will develop more collaboratively. By integrating the links in the tourism industry chain, the overall optimization and upgrading of the tourism industry will be achieved. Fourth, sustainable

development will be valued. Smart tourism will pay more attention to environmental protection and resource conservation to achieve sustainable development of the tourism industry. Figure 2 shows smart tourism destinations [4].

Fig. 2 Smart tourism destinations

3. Model Construction and Case Analysis

3.1 Recommendation Model Construction

3.1.1 Model Design

The primary objective of the smart tourism personalized recommendation model developed in this study is to enhance the accuracy and real-time performance of recommendations, cater to the personalized needs of tourists, and improve their travel experience. Specifically, the model needs to achieve the following goals: first, it can accurately predict tourists' preferences for tourism projects and provide tourists with accurate tourism recommendations; second, it can dynamically adjust the recommendation results according to tourists' real-time behavior and needs to achieve real-time recommendations; third, it can process large-scale tourism data and user behavior data to ensure the efficiency and scalability of the model; fourth, it can provide valuable decision-making support for tourism companies and help tourism companies optimize the design and operation of tourism products and services [5].

During the model design process, the following principles must be followed: the first is the data-driven principle. The model's construction and optimization should rely on extensive data from tourism and user behavior. Through the analysis and mining of the data, laws, and patterns can be discovered. The second is the openness. The model should exhibit strong openness and scalability, facilitating seamless integration of new technologies and algorithms to meet the changing demands of smart tourism. The third is explainability. The model's recommendation results need to have a certain degree of explainability so that tourists can understand why these tourism projects are recommended. The fourth is the security. The model must prioritize data security and privacy protection to ensure that tourists' personal information and behavioral data are not compromised or misused [6].

3.1.2 Data Processing and User Portraits

Data processing and user portraits are key links in building a personalized recommendation model. The data required for this study mainly include tourist behavior data, tourism resource data, and external environment data.

Since the collected data may be missing, noisy, inconsistent, and contain other issues, it is necessary to clean and convert the data to improve its quality and availability. Through data cleaning and conversion, the data can be standardized and unified, providing a solid foundation for subsequent data analysis and model building.

User feature analysis is the basis for building user portraits. By analyzing tourists' basic information, behavioral data, and evaluation data, we can gain a deeper understanding of tourists' interests, hobbies, spending power, travel purposes, and other characteristics. This study employs

machine learning and data mining techniques to construct user profiles. Specifically, clustering algorithms and classification algorithms are used to classify and model tourists. Clustering algorithms can aggregate tourists with similar characteristics into groups, thereby enabling a deeper understanding of the interests and needs of tourists from different groups. Classification algorithms can predict tourists' preferences for travel projects based on their historical behavioral data, offering personalized travel recommendations tailored to each individual.

Since tourists' interests and needs may change over time, user portraits need to be updated and maintained regularly to ensure their timeliness and accuracy. The updating and maintenance of user portraits primarily involve data updates, model optimization, and parameter adjustments.

3.1.3 Algorithm Optimization and Model Evaluation

To enhance the performance and real-time capabilities of the recommendation algorithm, this study employs the strategy of algorithm fusion and optimization. Specifically, the collaborative filtering algorithm and the content-based recommendation algorithm are combined, and a deep learning model is integrated to enhance the algorithm's performance. In the process of algorithm fusion, it is necessary to determine the weights and fusion methods of different algorithms to achieve the best recommendation effect. Additionally, the algorithm requires optimization, such as utilizing distributed computing technology to enhance its operating efficiency and employing incremental learning technology to facilitate real-time updates.

To objectively evaluate the performance of the recommendation model, this study set the following evaluation indicators: one is accuracy, which is used to measure the accuracy of the recommendation model in predicting user preferences; the second is recall, which is used to measure the ability of the recommendation model to recall items of interest to users; the third is F1-Score, which is used to comprehensively measure the accuracy and recall of the recommendation model; the fourth is mean absolute error (MAE), which is used to measure the average error between the predicted score of the recommendation model and the actual score.

3.2 Case Analysis

3.2.1 Case Selection

This study selected two typical smart tourism personalized recommendation application cases, one from China ("Trip") and one from a foreign country ("Expedia"), for analysis. These two cases are representative of the field of smart tourism personalized recommendations and can provide us with useful references.

3.2.2 Case Analysis

"Trip" is a leading online travel service provider in China. Its personalized recommendation system is based on AI technology. It provides users with personalized travel recommendation services by analyzing and mining user behavior data. The system employs a hybrid recommendation algorithm that combines a collaborative filtering algorithm and a content-based recommendation algorithm, utilizing deep learning models to enhance the accuracy and real-time performance of recommendations. In terms of data processing, the system integrates multi-source data, including user browsing records, booking records, and evaluation records, and cleans and converts the data to enhance the quality and availability of the data. In terms of user portrait construction, the system utilizes clustering algorithms and classification algorithms to categorize and model users, thereby understanding their interests and needs [7].

"Expedia" is a world-renowned online travel company, and its personalized recommendation system also uses advanced AI technology. The system provides users with personalized travel recommendation services by analyzing their historical behavior data, travel preferences, and external environment data. The system uses a deep learning model to process complex travel data and user behavior data, thereby improving the accuracy and real-time nature of recommendations. In terms of algorithm optimization, the system utilizes distributed computing technology and incremental learning techniques to enhance the algorithm's operational efficiency and real-time update capabilities.

Through the analysis of these two cases, it becomes clear that the application of AI technology in smart tourism, particularly in personalized recommendations, has yielded remarkable results. On the one hand, the personalized recommendation system can provide users with more accurate and personalized tourism recommendation services, meet the diverse needs of users, and enhance their travel experience; on the other hand, the personalized recommendation system can also bring considerable economic benefits to tourism companies, improve their service quality and operational efficiency, and enhance their competitiveness.

4. Challenges and Countermeasures

4.1 Challenges

In the process of smart tourism, personalized recommendations, data quality, and privacy security are the two main challenges. On the one hand, due to the wide range of data sources and uneven data quality, it isn't easy to integrate multi-source heterogeneous data, which will affect the accuracy and reliability of the recommendation model. On the other hand, tourists' personal information and behavioral data are sensitive. Once leaked, it will bring potential risks to tourists. Therefore, data privacy and security protection are crucial.

Existing recommendation algorithms frequently encounter issues, including low recommendation accuracy and poor real-time performance, when handling large-scale data and complex scenarios. In addition, the explainability of recommendation algorithms is also a pressing issue that needs to be addressed. Tourists often want to understand why these travel projects are recommended, but existing recommendation algorithms often struggle to provide clear explanations.

Additionally, tourism resources are dynamic, such as the opening hours of scenic spots, ticket prices, and hotel room availability, which are subject to change over time. Therefore, it is challenging to generate real-time recommendations, and the recommendation model must be able to obtain dynamic information about tourism resources promptly and adjust the recommendation results accordingly.

4.2 Coping Strategies

In response to the challenges faced by smart tourism, personalized recommendations can be addressed through the following strategies. In terms of data management and privacy protection, a sound data quality assessment system should be established to regularly clean and integrate multi-source heterogeneous data. At the same time, technical measures such as data encryption and access control should be implemented to enhance security management during data collection, storage, and transmission, thereby protecting the privacy of tourist information. In terms of algorithm optimization and interpretability enhancement, advanced machine learning and deep learning technologies should be integrated to optimize algorithm performance, thereby improving recommendation accuracy and real-time performance. Furthermore, rule-based or case-based interpretation technologies should be developed to provide tourists with a clear basis for recommendations. In response to the dynamic changes in tourism resources and the challenge of real-time recommendation, a mechanism for collecting and processing real-time data should be established. With the help of distributed computing and real-time data processing technologies, dynamic updates of tourism resource information and timely adjustments of recommendation results can be achieved, meeting the real-time requirements of smart tourism.

5. Conclusion

This study developed a personalized smart tourism recommendation model utilizing AI technology, examining its theoretical foundation, construction process, case studies, and the challenges encountered by the model. The research results indicate that AI technology has broad application prospects in smart tourism, particularly in personalized recommendations, which can provide tourists with more accurate and personalized tourism recommendations, enhance their travel experience, and also bring considerable economic benefits to tourism enterprises.

In the future, the research and application of smart tourism personalized recommendation models will continue to develop in a more intelligent, personalized, and humanized direction. On the one hand, with the continuous development and progress of AI technology, the recommendation model will be able to more accurately understand the needs and preferences of tourists and provide tourists with more personalized tourism recommendation services; on the other hand, the recommendation model will pay more attention to user experience and provide tourists with a more convenient and comfortable travel experience. Additionally, the recommendation model will be deeply integrated with other technologies, such as virtual reality and augmented reality, to provide tourists with a richer and more diverse travel experience.

Furthermore, we must also acknowledge that the research and application of smart tourism personalized recommendation models still face several challenges, including data privacy and security, as well as algorithm interpretability. Therefore, we need to conduct further research and exploration of these issues to promote the continuous improvement and development of smart tourism personalized recommendation models.

References

[1] Awujoola O J, Awujoola A E, Adelegan O R, et al. Machine learning-based predictive modeling for brain tumor analysis in a society 5.0 framework[J]. Human- Centric Integration of Next-Generation Data Science and Blockchain Technology, 2025:127-146.

[2] Li K , Sun D .A Global-Features and Local-Features-Jointly Fused Deep Semantic Learning Framework for Error Detection of Machine Translation[J].Journal of Circuits, Systems & Computers, 2025, 34(1).DOI:10.1142/S0218126625500252.

[3] Azura S N, Juniati W, Bienladen U. Sustainability-oriented innovation in smart tourism: challenges and pitfalls of technology deployment for sustainable destinations[J]. European Planning Studies, 2025, 33(4): 669-670. DOI: 10.1080/09654313.2024.2342992.

[4] Yan J, Wang M, Xue R. Hybrid recommendation system based on human-computer interaction technology and smart tourism[J]. International Journal of Ad Hoc and Ubiquitous Computing, 2025.DOI:10.1504/IJAHUC.2025.143545.

[5] Galvão A, Brito e Abreu F, Joanaz de Melo J. Towards a consensual definition for smart tourism and smart tourism tools[C]//Kornyshova E, Deneckère R, Brinkkemper S (eds). Smart life and smart life engineering: current state and future vision. Cham: Springer Nature, 2025: 153-182. DOI:10.1007/978-3-031-75887-4_8.

[6] Yin F, Yin X, Zhou J, et al. Tourism cloud management system: the impact of smart tourism[J]. Journal of Cloud Computing, 2022, 11(1):1-11. DOI:10.1186/s13677-022-00316-3.

[7] Nieves-Pavon S, Lopez-Mosquera N, Jimenez-Naranjo H. The role emotions play in loyalty and WOM intention in a Smart Tourism Destination Management[J]. Cities, 2024, 145(Feb.):104681.1-104681.14. DOI:10.1016/j.cities.2023.104681.